

SOME OBSERVATIONS ON THE CERVICAL SYMPATHETIC IN MAN

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WITHIN recent years the anatomy of the cervical sympathetic has attracted attention on account of the operations described by Jonnesco⁽⁵⁾ and others, e.g. Daniélopou⁽²⁾, Holmes and Ranson⁽³⁾, for angina pectoris, Graves' disease, and certain other conditions, but more especially on account of the operation of sympathetic ramisection devised by Royle^(9, 10, 11), in collaboration with the late Prof. Hunter⁽⁴⁾, for the treatment of spastic paralysis. Realising the need of more accurate anatomical information as a guide to the surgeon in performing the operation of ramisection, Potts⁽⁸⁾ has recently published a description, accompanied by a series of excellent plates, of the main peripheral connections of the human sympathetic.

The subject-matter of the present communication is based on nine complete dissections of the cervical sympathetic, as well as on the examination of parts of it in about a dozen other specimens. In connection with this investigation a cast has been made, under my direction, of a complete dissection of the whole sympathetic chain and its rami communicantes, and has been placed in the Anatomical Museum of the University of Otago. Although in the main my findings agree with those of Potts, certain points appear to me worthy of further discussion, and I also desire to add a more detailed description of the course of the rami communicantes in the specimens which I have dissected.

The observations which are recorded in the following pages fall under three main headings: (A) The arrangement of the cervical ganglia, (B) The histological structure of the cervical ganglia, and (C) The arrangement of the rami communicantes in the cervical region.

A. THE ARRANGEMENT OF THE CERVICAL GANGLIA

Text-book descriptions, e.g. Cunningham⁽¹⁾, Piersol⁽⁶⁾, Poirier and Charpy⁽⁷⁾, and Spalteholz⁽¹²⁾, usually mention three ganglia, viz. superior, middle, and inferior, as being normally present. It is, however, not infrequently added that the middle ganglion may be absent. Both Cunningham and Poirier and Charpy further state that the middle ganglion may be divided into two parts, a fact which they regard as evidence of its morphological derivation from the Vth and VIth cervical ganglia.

Both Potts⁽⁸⁾ and Jonnesco⁽⁵⁾ agree that the middle cervical ganglion may be absent. In addition, Potts describes two common positions in which the

middle ganglion, when present, may be found; while Jonnesco states that in some cases the middle ganglion is represented by a number of small thickenings on the sympathetic chain. Further, Jonnesco describes a fourth cervical ganglion, also inconstant, which he terms the intermediate ganglion; according to his description, this ganglion, when present, lies ventro-medial to the vertebral artery at the root of the neck and is cephalic to the inferior cervical ganglion; he states that it is as frequently present as is the middle ganglion, and that it may occur either in the presence or in the absence of a middle ganglion.

It is, then, evident that the superior and inferior cervical ganglia are definite large thickenings of the sympathetic chain, situated respectively high up and low down in the neck; that both are invariably present; and that there is little or no variation in their position. With regard to these ganglia I have nothing to add to what has already been recorded: variations in their shape and size are well known, as is also fusion or non-fusion of the inferior cervical ganglion with the 1st thoracic ganglion, to which I shall refer in connection with the rami communicantes to the 1st thoracic nerve.

On the other hand, the position with regard to the middle cervical ganglion is far from clear, and more evidence is required as to the significance of the intermediate ganglion of Jonnesco. Although I have investigated only a comparatively small number of cases, the following points will, I think, be of interest.

1. *Regarding the Middle Cervical Ganglion*

In the great majority of cases which I have examined the middle cervical ganglion was present as a definite thickening of the sympathetic chain. Such cases, as has also been noted by Potts, fall into two types: (a) those in which the middle cervical ganglion lies in close association with the inferior thyroid artery at about the level of the VIth cervical vertebra; and (b) those in which the middle cervical ganglion lies on the ventral aspect of the vertebral artery at about the level of the VIIth cervical vertebra; the former may be termed the high type, and the latter the low type, of middle cervical ganglion. In the cases which I have examined the low type occurred more frequently than the high. The condition on opposite sides of the neck is not necessarily the same.

(a) *In the high type* (fig. 1), the ganglion takes the form of a flattened, oval or ovoid thickening resting on the longus colli muscle at the level of the Vth or VIth cervical transverse process, being most often in relation to the carotid tubercle of Chassaignac. It has an important relation with the inferior thyroid artery where this vessel bends medially to pass dorsal to the carotid sheath, for which reason, according to Poirier and Charpy⁽⁷⁾, it has been termed by Haller the "thyroid ganglion." It may lie a little above or a little below the bend in the artery, though I found it most often lying directly behind the vessel. Jonnesco⁽⁵⁾ describes it as being often split by the artery, which then passes through it as through a button-hole; in such cases he states that the main bulk of nerve fibres passes up through the posterior limb of

the loop. The high type of ganglion gives rami communicantes constantly to the Vth and VIth cervical nerves, occasionally also to the IVth or even to the IIIrd cervical nerve.

(b) *In the low type* (fig. 2), no thickening is present on the sympathetic chain at the level of the VIth cervical vertebra, but a pyramidal enlargement of the chain lies directly on the ventral or ventro-medial aspect of the vertebral artery 1 to 3 cm. above its origin, this level being generally that of the VIIth

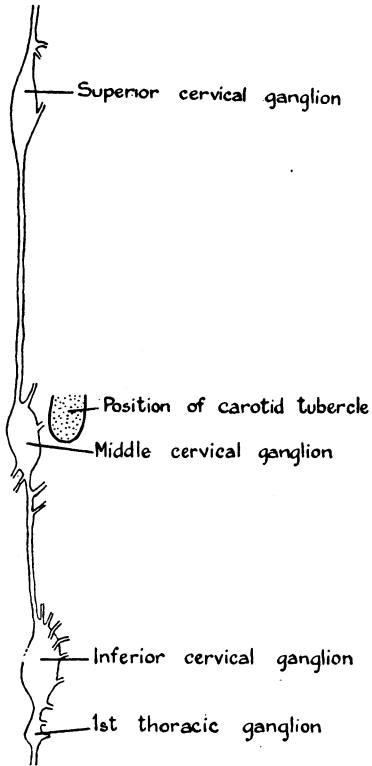


Fig. 1. Left cervical sympathetic chain with middle ganglion in its high position.

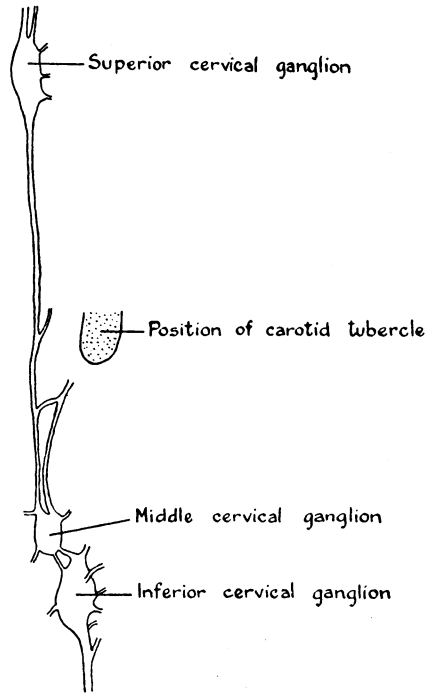


Fig. 2. Left cervical sympathetic chain with middle ganglion in its low position.

cervical vertebra. This ganglion is connected to the inferior cervical ganglion in two ways: firstly, by the ansa subclavia encircling the first part of the subclavian artery, and, secondly, by two bands which encircle the vertebral artery to join the inferior cervical ganglion, which lies dorsal to that vessel. The rami communicantes from the low type of ganglion are distributed most frequently to the Vth and VIth cervical nerves, but there is some variation in that I have seen rami proceeding from it to the Vth cervical nerve alone, and to the Vth, VIth, and VIIth cervical nerves.

Three cases among those which I have examined did not conform to either of these two types.

In two of these cases it appeared at first sight that no middle cervical ganglion was present. After careful dissection, however, it was clear that a small thickening of the chain existed on the ventral aspect of the vertebral artery in the exact position occupied by the low type of middle cervical

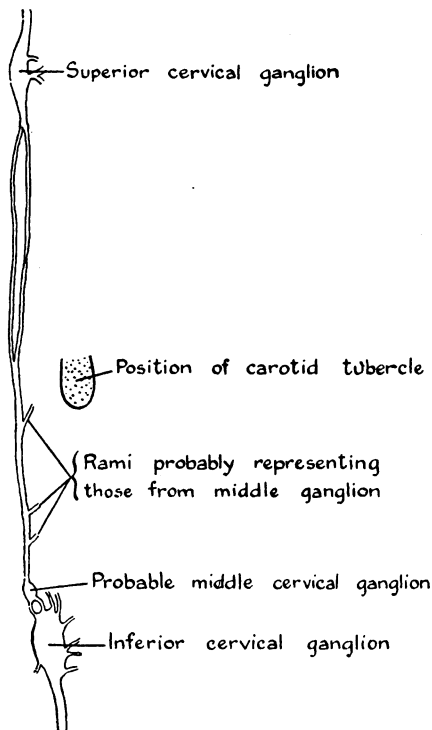


Fig. 3. Left cervical sympathetic chain with apparent absence of the middle cervical ganglion. This figure shows a small thickening in the position of a low type of middle ganglion, but no rami communicantes arise from it. See text for possible explanation.

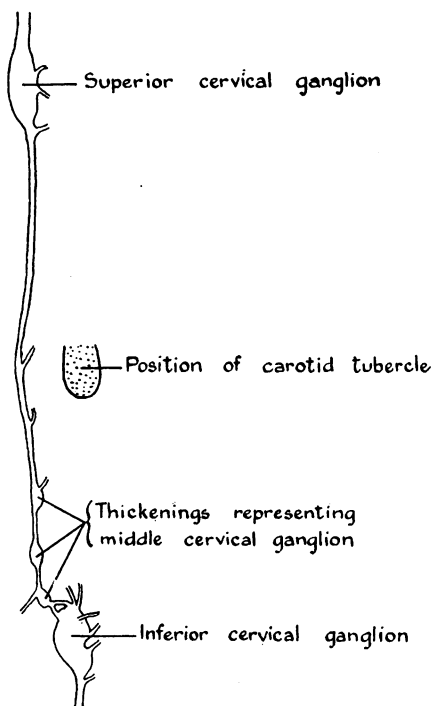


Fig. 4. Left cervical sympathetic chain with apparent absence of the middle cervical ganglion. Three thickenings of the chain, each showing actual nerve cells microscopically, evidently represent a "multiple ganglia" condition of the middle ganglion.

ganglion (fig. 3), but it gave no rami communicantes to the cervical nerves. The following points make it at least possible that this small thickening was actually a middle cervical ganglion: firstly, that it occupied the same position as a definite middle cervical ganglion of the low type; secondly, that the rami communicantes to the Vth and VIth cervical nerves, though not proceeding from this small thickening, arose from the trunk immediately above it (fig. 3), as though they had "slipped up" a little (this condition is often present in

cases of a definite middle ganglion either of the high or of the low type, and affects one or more rami communicantes); and, thirdly, that on histological examination the small thickening was found to contain nerve cells.

In the third of the atypical cases (fig. 4), the middle cervical ganglion was represented by a small thickening lying on the ventral aspect of the vertebral artery and by two smaller thickenings on the chain above this—the condition of multiple ganglia mentioned by Jonnesco. On histological examination the three small thickenings were found to contain nerve cells.

2. Regarding the Intermediate Cervical Ganglion of Jonnesco

In its position and in its relation to the vertebral artery the intermediate ganglion of Jonnesco obviously corresponds to the low type of middle cervical ganglion (fig. 2) described in this paper.

Jonnesco, however, as has already been pointed out, states that his intermediate ganglion may occur either in the presence or in the absence of a middle cervical ganglion.

In those cases where, according to Jonnesco, his intermediate ganglion exists in the absence of a middle cervical ganglion, I contend, from my observations on the rami communicantes, that we have before us simply a low type of middle cervical ganglion. In those cases where, according to Jonnesco, both his intermediate ganglion and the middle cervical ganglion are present at the same time, I would suggest that either, firstly, the middle ganglion is present in its high position and a small piece of it is cut off and lies in the low position, or, secondly, that the middle ganglion is represented by two thickenings, one in the position of the low type of middle cervical ganglion (this being Jonnesco's intermediate ganglion) and the other on the chain just above this—the first stage in the production of the condition of multiple ganglia representing the middle cervical ganglion.

B. THE HISTOLOGICAL STRUCTURE OF THE CERVICAL GANGLIA

In the following statements Jonnesco (5) throws doubt on the true ganglionic nature of certain of the thickenings of the cervical sympathetic chain which from their macroscopic appearance would be described as ganglia:

(1) "En effet, au niveau de l'artère thyroïdienne inférieure, où se trouve ce ganglion (i.e. the middle cervical ganglion), quand il existe, le cordon sympathétique peut présenter un renflement, pareil à d'autres qui peuvent exister sur tout le trajet du cordon, sans être le véritable ganglion cervical moyen."

(2) "Au-dessous du ganglion intermédiaire, qui, ainsi que le ganglion moyen, n'a que l'apparence d'un ganglion nerveux, mais histologiquement n'est qu'un simple renflement nerveux, nous trouvons la masse ganglionnaire formée par l'union du dernier ganglion cervical au premier thoracique."

With the object of verifying the above statements, I examined a number of ganglia taken from dissecting-room subjects and from post-mortems, and in all cases I found nerve cells present.

C. THE ARRANGEMENT OF THE RAMI COMMUNICANTES IN THE CERVICAL REGION

As it is with these fine nerves that the surgeon is concerned in the operation of Sympathetic Ramisection, I have carefully investigated their course in a number of cases, giving special attention to those which proceed to the roots of the brachial plexus. In the main my dissections confirm the account given by Potts (8), but I have noticed a few new facts, and in this section of the paper I propose to give a detailed account of the course taken by the rami in the cases which I have examined.

In the first place it is important to distinguish between true rami communicantes and other extremely numerous branches of the sympathetic, e.g. visceral and arterial. In general it is possible to differentiate between the two sets of branches by the direction which they take in their course from the sympathetic chain. Thus, the visceral branches to the pharynx, larynx, thyroid gland, heart, etc. are directed (*a*) in the upper part of the neck, medially and a little forwards, and (*b*) in the lower part of the neck, downwards, medially, and forwards. On the other hand, the rami communicantes are directed (*a*) in the upper part of the neck, directly outwards, and (*b*) in the lower part of the neck, either directly upwards, or upwards and backwards, or upwards and outwards. In my figures, all of which are drawn from actual dissections, I have, with one or two exceptions, purposely omitted, for the sake of clearness, all branches of the sympathetic other than true rami communicantes. The direction of the rami communicantes shown in the figures will be seen to agree with the general statement of their direction given above.

The individual rami communicantes will be described according to the spinal nerves to which they proceed.

1. *Grey Rami to the first four Cervical Nerves, i.e. to the Nerves of the Cervical Plexus*

The first four cervical nerves are commonly united by communicating links forming three large loops just at, or a little lateral to, the lateral border of the rectus capitis anticus major muscle.

The grey rami to these nerves (figs. 5, 6 and 12) generally arise from the superior cervical ganglion on its lateral or anterior aspect, and they are usually three in number, as follows:

(*a*) The uppermost is a short filament joining either the 1st cervical nerve, just as it appears lateral to the rectus capitis anticus minor muscle, or the loop between it and the 2nd cervical nerve.

(b) The middle ramus is a similar short branch joining either the IInd cervical nerve or the loop between it and the IIIrd cervical nerve.

(c) The lowest ramus arises from the lower part of the ganglion and joins either the IIIrd cervical nerve or the loop between it and the IVth cervical nerve.

In many cases these are the only grey rami to the first four cervical nerves. I have, however, observed the following variations in this arrangement.

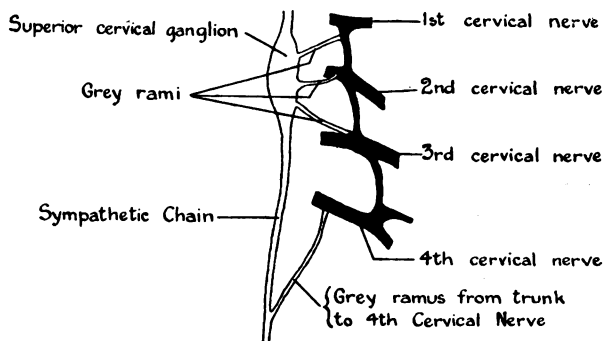


Fig. 5. A typical arrangement of rami communicantes to the first four cervical nerves. Left side of neck.

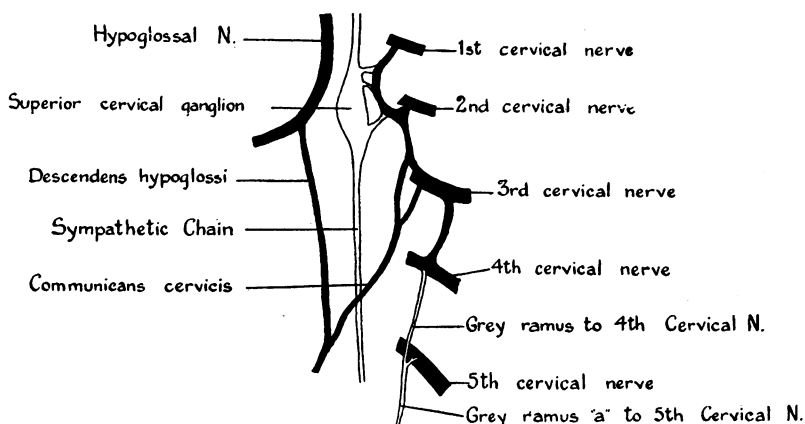


Fig. 6. Showing a ramus to the IVth cervical nerve arising from a ramus to the Vth cervical nerve. Left side of neck.

- (1) The uppermost ramus may be double.
- (2) The lowest ramus may be absent.
- (3) Another grey ramus may be present, passing to join the IVth cervical nerve. This ramus is interesting in that it does not arise from the superior cervical ganglion. It is commonly present in the absence of the lowest of the three rami which arise from that ganglion. Frequently it takes origin from the sympathetic trunk at about the level of the carotid tubercle (figs. 5 and 12);

it then passes upwards and slightly outwards across the surface of the rectus capitis anticus major, and joins the IVth cervical nerve on its anterior aspect just after it has emerged from the lateral border of that muscle. In other cases (fig. 6) it is a continuation upwards of a ramus to the Vth cervical nerve, which joins the latter just above and lateral to the carotid tubercle; it is a fine filament passing upwards anterior to the Vth cervical nerve, and is just overlapped by the lateral border of the rectus capitis anticus major; occasionally it is continued still further cranially to join the IIIrd cervical nerve in a similar manner.

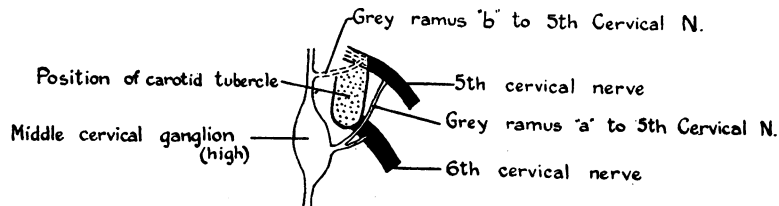


Fig. 7. Showing two rami to the Vth cervical nerve, the constant ramus "a" from a high middle ganglion, and the first inconstant ramus "b." Left side of neck.

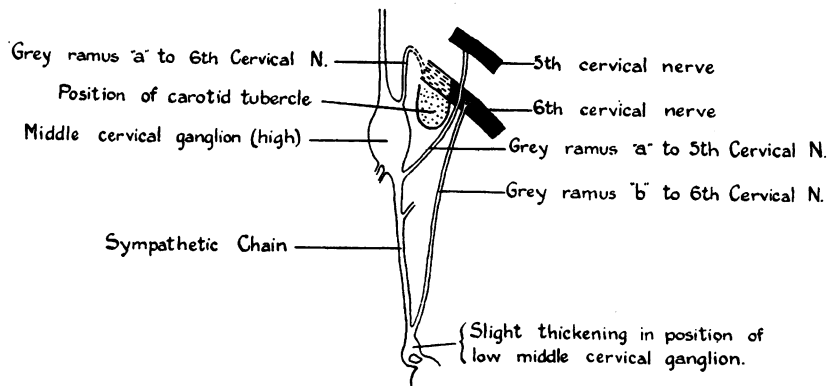


Fig. 8. Showing certain rami to the Vth and VIth cervical nerves. Left side of neck.

2. Grey Rami to the Vth Cervical Nerve

In the cases which I have examined the Vth cervical nerve receives either one or two or three grey rami. Of these, one was present in all cases and will therefore be termed here the constant grey ramus; the other two, which were not present in all cases, may be termed inconstant.

(a) *The constant grey ramus.* See figs. 7 to 10, where it is labelled "Grey ramus 'a' to 5th Cervical N."¹; it is also indicated in figs. 6 to 12.

¹ In figs. 5 to 13 the grey rami to the Vth, VIth, VIIth and VIIIth cervical nerves are labelled with reference to the sections of the text in which they are described. Thus, "Grey ramus 'a' to 5th Cervical N." is the ramus described in the text under heading (a) of the rami to the Vth cervical nerve; "Grey ramus 'c' to 6th Cervical N." is the ramus described under heading (c) of the rami to the VIth cervical nerve; and so on.

It is a fine filament which arises either directly from the middle cervical ganglion (whether this be of the high or of the low type) or from the sympathetic trunk just above a low type of middle ganglion.

When it arises from a middle cervical ganglion of the low type (fig. 9), it passes upwards and outwards across the vertebral artery and thus reaches the superficial surface of the scalenus anticus muscle close to its origin. Here it is often joined by a small branch which leaves the trunk at the level of the carotid tubercle. It passes upwards across the scalenus anticus, winds closely round the lateral aspect of the carotid tubercle, and joins the Vth cervical nerve (where it lies in the groove on the upper surface of the Vth cervical transverse process) on its anterior or antero-inferior aspect; the point of junction is just at the lateral border of the rectus capitis anticus major.

When this ramus arises either from the sympathetic trunk above a middle ganglion of the low type or directly from a middle ganglion of the high type (figs. 7 and 8), it passes more directly across the vertebral artery to reach the superficial surface of the scalenus anticus; thereafter its course is the same as above.

This ramus exhibits the following variations in its course and termination: (1) it may pierce some fibres of the scalenus anticus before reaching the lateral aspect of the carotid tubercle; (2) it may divide, before reaching the Vth cervical nerve, into two branches, one of which then joins the VIth cervical nerve (fig. 7); (3) it may be prolonged upwards as a fine filament passing to join the IVth cervical nerve (fig. 6); this has already been described in connection with the grey rami to the first four cervical nerves.

(b) *The first inconstant ramus* (fig. 7). This was present in the great majority of my specimens. It arises from the sympathetic trunk just above the carotid tubercle. Either immediately or after an upward course of a few millimetres, it pierces the longus colli muscle, running posteriorly through the muscle close to the disc between the IVth and Vth cervical vertebrae. It passes either medial or lateral to the vertebral artery, and joins the Vth cervical nerve as it lies in the groove of the Vth cervical transverse process. It has in addition some connections with the vertebral arterial plexus.

(c) *The second inconstant ramus* (fig. 11). This is a fine branch arising from a ramus which accompanies the vertebral artery and which is mainly distributed to the VIth cervical nerve. (See ramus described under heading (c) of the grey rami to the VIth cervical nerve.)

3. *Grey Rami to the VIth Cervical Nerve*

I have dissected four distinct grey rami communicantes to this nerve. One of these ((c) below), which arises from the inferior cervical ganglion, was present in every case. Of two others ((a) and (b) below), which arise from the middle ganglion or from the sympathetic trunk, one or other was always present, and in quite a number of cases both were present. A fourth ramus ((d) below), arising from the inferior ganglion, was present in two cases, in

both of which only one ramus from the middle ganglion was present. It would thus appear that in any given case the VIth cervical nerve may receive either two or three grey rami communicantes, each of which has a definite course and should be carefully searched for at operation.

(a) *A ramus arising either from a middle cervical ganglion of the high type, or from the trunk immediately above it, or from the trunk just above a middle ganglion of the low type* (figs. 8 and 12). This is a short ramus running upwards for a few millimetres from its origin and then piercing the longus colli muscle just above the level of the carotid tubercle and just below a similar branch to the Vth cervical nerve which has already been described. It passes posteriorly through the muscle close to the disc between the Vth and VIth cervical vertebrae to join the VIth cervical nerve as it lies in the groove of the VIth cervical transverse process. In all cases it passed medial to the vertebral artery in order to join the nerve.

In all cases in which the middle cervical ganglion was of the high type, this ramus was present and arose from that ganglion or from the trunk immediately above it. When, however, the ganglion is of the low type, the ramus is inconstant but may still be present as a branch from the trunk at the level of the VIth cervical vertebra, irrespective of the presence or absence of another ramus from the ganglion itself to the same cervical nerve (*vide infra*).

(b) *A ramus arising either from a middle cervical ganglion of the low type or from the trunk just above this level* (figs. 8, 9, 10 and 12). This is a long fine branch which passes upwards anterior to the lower cervical nerve roots. It crosses the anterior aspect of the vertebral artery obliquely as the artery is proceeding upwards to the foramen in the VIth cervical transverse process. It then reaches the superficial surface of the scalenus anticus muscle, across which it runs, lateral to the carotid tubercle, to join the VIth cervical nerve just under cover of the rectus capitis anticus major.

In the case of this ramus I have observed the following variations: (1) it may receive a connection from the trunk just above the middle cervical ganglion; (2) it is often continued (fig. 6) upwards at the lateral border of the rectus capitis anticus major in order to join the Vth cervical nerve, as described above in connection with ramus "a" to the Vth cervical nerve (variation 2); (3) it often pierces the upper part of the scalenus anticus just below the carotid tubercle and just before joining the nerve.

When the middle cervical ganglion was of the low type, this ramus was present in most cases and arose from that ganglion. When the ganglion is of the high type, the ramus may be present as a branch from the trunk just above the slight thickening which in my cases was invariably present on the ventral aspect of the vertebral artery.

(c) *A constant ramus arising from the inferior cervical ganglion* (figs. 10 and 11). In my series of specimens this ramus was constantly present, and is quite distinct from the ramus which has just been described.

It is a fairly thick branch arising from the deeper part of the inferior

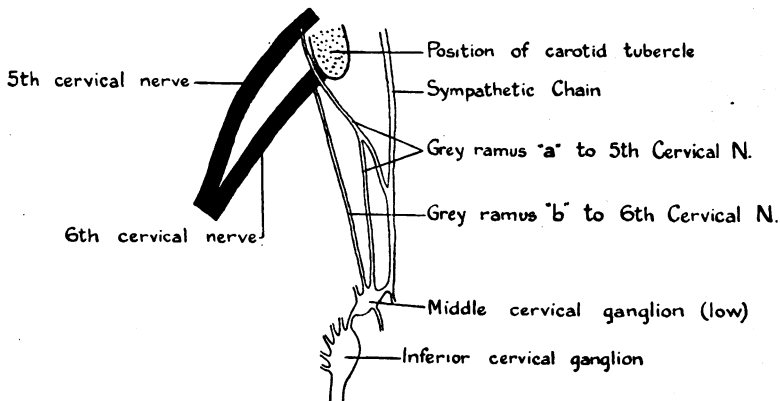


Fig. 9. Showing rami from a middle cervical ganglion in the low position to the Vth and VIth cervical nerves. Right side of neck.

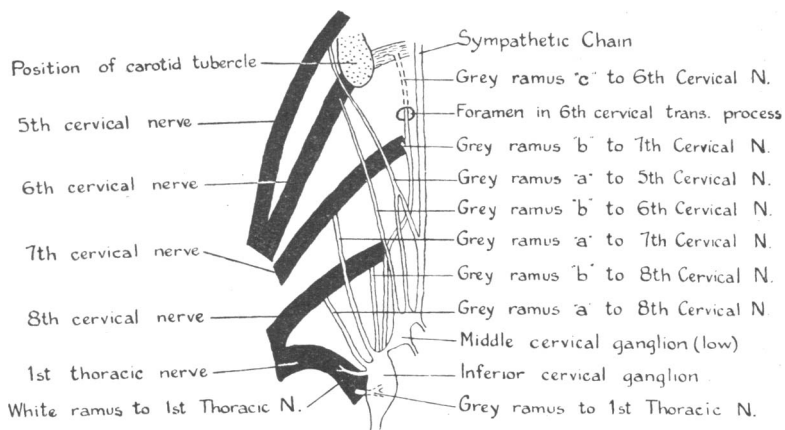


Fig. 10. Showing some of the rami arising from a middle cervical ganglion in the low position and from the inferior cervical ganglion. Right side of neck.

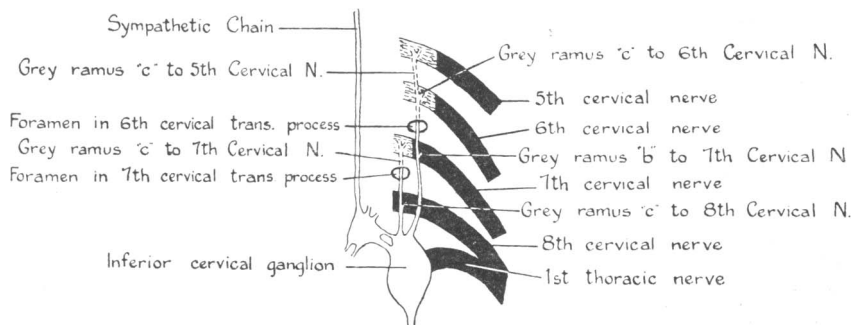


Fig. 11. Showing two rami from the inferior cervical ganglion (all others omitted). Left side of neck.

cervical ganglion. It runs upwards along the medial side of the vertebral artery, anterior to the vertebral vein, and to the lateral side of the longus colli muscle; it is thus situated in a narrow isosceles triangle, as mentioned by Potts, and bounded as follows: (a) medially, by the lateral border of the longus colli muscle; (b) laterally, by the vertebral artery; and (c) inferiorly—the short base of the triangle—by the neck of the first rib, with the inferior cervical ganglion lying in front of it. In its course upwards from the ganglion the ramus crosses anteriorly, in turn, the neck of the first rib (if the ganglion is below this), the VIIIth cervical nerve, and the transverse process of the VIIth cervical vertebra. At this point it gives some of its fibres to the VIIth cervical nerve; these fibres join the nerve just lateral to its emergence from the intervertebral foramen. The ramus then courses upwards anterior to the VIIth cervical nerve, and, in company with the vertebral artery, enters the foramen in the transverse process of the VIth cervical vertebra.

By removing the anterior bar of the VIth cervical transverse process and then displacing laterally the vertebral artery and its venae comites, I have found that the ramus either wholly or in part joins the VIth cervical nerve either in or just lateral to the intervertebral foramen. In a few cases careful dissection revealed the fact that some of the fibres of the ramus continued upwards in front of the VIth cervical nerve and passed through the arterial foramen in the Vth cervical vertebra to join the Vth cervical nerve in a similar manner. (See ramus referred to under heading (c) of the rami to the Vth cervical nerve.)

It has been clear to me, in the course of my dissections, that many of the fibres from this ramus become incorporated in the sympathetic plexus surrounding the vertebral artery. But I have been surprised at the comparative ease with which definite connections with the cervical nerves mentioned can be demonstrated.

The ramus has been noticed by others but its significance has not, to my knowledge, previously been stressed. Jonnesco⁽⁵⁾ describes the branch in this position as an arterial branch *receiving* fibres from the Vth, VIth, and VIIth cervical nerves, showing that he had noted the connections which it has with these nerves. Spalteholz⁽¹²⁾, on the other hand, mentions that branches of the vertebral arterial plexus are rami communicantes. The latter view seems to me to be very reasonable; and, while I am convinced from my own observations that the branch described above is a grey ramus to the VIIth and VIth cervical nerves, and frequently also to the Vth, I believe further that it is not at all unlikely that many fibres leave the vertebral arterial plexus throughout its course in the neck and are distributed to the seven cervical nerves with which it comes into intimate relation.

(d) *An inconstant ramus arising from the inferior cervical ganglion.* The ramus which has just been described was, as has already been pointed out, present in all my cases, and I have seen no variation in its course. In two cases, however, a second ramus to the VIth cervical nerve arose from the

inferior cervical ganglion. This was a fine branch accompanying the vertebral artery upwards for some distance, and crossing that vessel on its anterior aspect from within outwards. At the point where the artery entered the arterial foramen in the VIth cervical transverse process, the ramus left the artery to pass more laterally, pierced the scalenus anticus muscle, and joined the VIth cervical nerve just below the carotid tubercle. Its point of junction with the nerve was under cover of the upper fibres of the scalenus anticus.

4. *Grey Rami to the VIIth Cervical Nerve*

Commonly three grey rami communicantes are connected with the VIIth cervical nerve. Of these three, two were constant in my specimens and one inconstant; in certain cases one of the constant rami is represented by two or three separate filaments; thus, in any given case, the number of rami present may vary from two to five. All take origin from the inferior cervical ganglion.

(a) *The first constant ramus* (fig. 10). This is a well-defined nerve leaving the upper part of the inferior cervical ganglion and running upwards and laterally to join the VIIth cervical nerve on its inferior aspect either just medial to the lateral border of the scalenus anticus muscle or under cover of the muscle. It is from 1.5 to 2.5 cm. long, and during its course crosses the VIIIth cervical nerve anteriorly. The relation of the ramus to the scalenus anticus muscle is very variable. When the VIIth cervical nerve lies directly between the scalenus medius and scalenus anticus muscles, the ramus, before reaching the nerve, may cross partly the anterior surface of the scalenus anticus, pierce the muscle, or run entirely deep to it. When the VIIth cervical nerve is found piercing the muscle or even lying in front of it, the ramus correspondingly either pierces the muscle or lies in front of it.

The ramus is often accompanied by a similar branch running parallel to it on its medial side, and joining the VIIth cervical nerve immediately above it. In one case (fig. 12), I found three parallel rami in this position running upwards and outwards to join the VIIth cervical nerve under cover of the scalenus anticus muscle.

(b) *The second constant ramus* (figs. 10 and 11). This ramus is fully discussed above under heading (c) of the rami to the VIth cervical nerve.

It courses upwards on the medial aspect of the vertebral artery at the lateral border of the longus colli muscle. It passes anterior to the VIIIth cervical nerve and the transverse process of the VIIth cervical vertebra, and then joins the VIIth cervical nerve either in or just lateral to the intervertebral foramen. It then continues upwards through the arterial foramen to the VIth, and sometimes also to the Vth, cervical nerves.

(c) *A third ramus frequently present in addition* (figs. 11 and 12). This ramus I found in the great majority of cases. It was sometimes a very definite strong ramus, and at other times extremely thin and delicate. It springs from the postero-superior aspect of the inferior cervical ganglion, and runs upwards

and a little backwards in close association with the vertebral vein. After crossing anterior to the VIIIth cervical nerve, to which it may give a small filament, it enters the foramen in the transverse process of the VIIth cervical vertebra in company with the vertebral vein. It joins the VIIth cervical nerve in the intervertebral foramen between the VIth and VIIth cervical vertebrae.

5. Grey Rami to the VIIIth Cervical Nerve

The grey rami to the VIIIth cervical nerve vary in number from two to five. Two alone are constant, but one of these may be represented by two, three, or four separate filaments. They are shorter than any of the preceding rami communicantes, the longest being only 2 cm. in length, and the average 1 cm. They all arise from the inferior cervical ganglion.

(a) *The first constant ramus* (figs. 10, 12 and 13). A well-defined thick branch, 1 to 2 cm. in length, arises from the lateral or superior aspect of the inferior cervical ganglion and courses upwards and outwards, often crossing the head or neck of the first rib, and joining the VIIIth cervical nerve as it lies behind the scalenus anticus muscle. It joins the nerve on its inferior, or less commonly on its anterior, aspect. It lies posterior to the first part of the subclavian artery, and bears a varying relation to the superior intercostal artery, being either superficial or deep to it, and in either case very intimately related to it.

The ramus is generally double and may be in three distinct branches. In one case I dissected four fine but distinct rami communicantes running parallel courses upwards and outwards to join the VIIIth cervical nerve deep to the scalenus anticus muscle or at its medial border.

(b) *The second constant ramus* (figs. 10 and 12). This is a short thick ramus arising from the upper pole of the inferior cervical ganglion, and running vertically upwards medial and posterior to the vertebral artery, a few millimetres lateral to the lateral border of the longus colli muscle. It passes in front of the transverse process of the first thoracic vertebra, medial to the first costo-central articulation, and joins the VIIIth cervical nerve on its anterior aspect just as it emerges from the intervertebral foramen.

(c) *A third ramus frequently present in addition* (fig. 11). This is a branch of the ramus described under heading (c) of the rami to the VIIth cervical nerve. This ramus runs upwards in company with the vertebral vein, and is medial to the ramus just described ((b) above), as seen in fig. 12. In most cases (fig. 11) this ramus gives a filament to the anterior aspect of the VIIIth cervical nerve as it crosses the latter on its way to the foramen in the VIIth cervical transverse process, but in some cases I could find no such connection with the VIIIth cervical nerve.

6. Rami Communicantes to the 1st Thoracic Nerve

An important feature of the 1st thoracic nerve is the fact that, in addition to having grey rami communicantes similar to those of the cervical nerves, it has also a white ramus communicans—the first of a series of 13 or 14 white

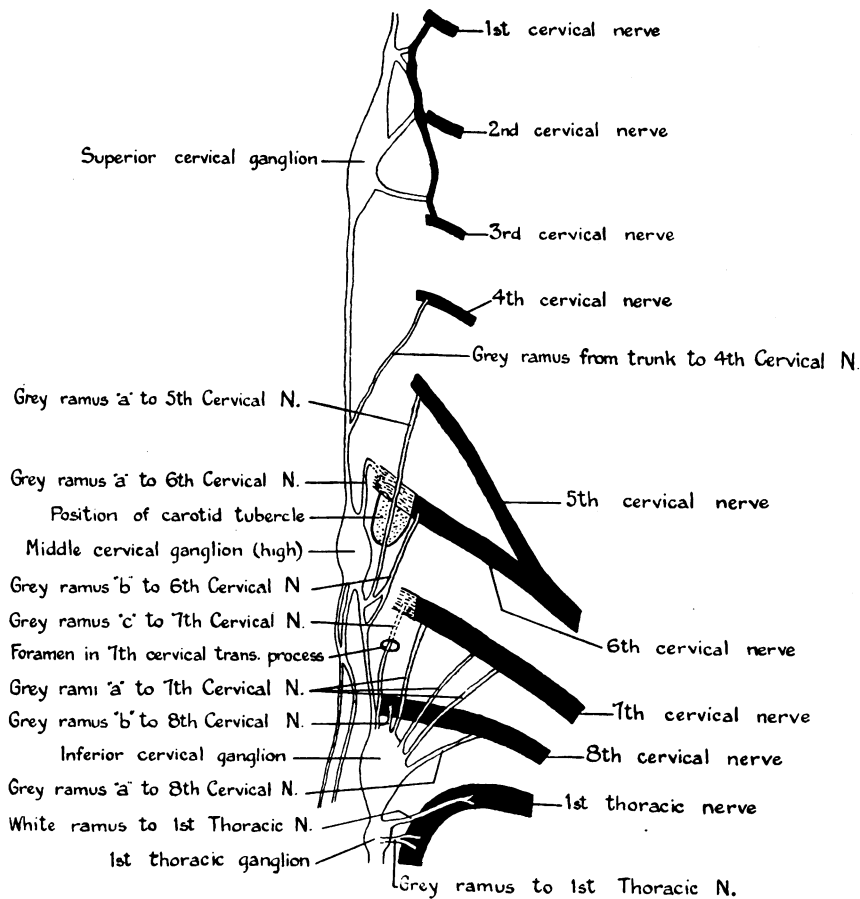


Fig. 12. Showing the arrangement of a number of rami communicantes in a dissection where the middle ganglion was in its high position. Left side of neck. The 1st thoracic ganglion is separated from the inferior cervical ganglion. The 1st thoracic ganglion has been retracted medially to put the rami on the stretch, and therefore the grey ramus to the 1st thoracic nerve is shown running laterally; actually this ramus runs almost directly backwards.

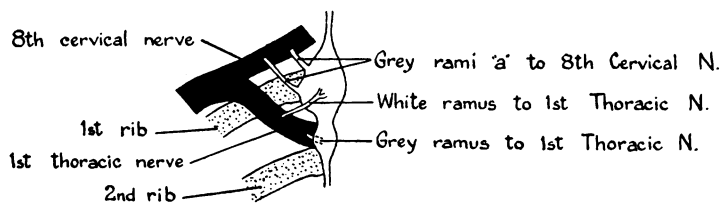


Fig. 13. Showing apparent separation of the 1st thoracic ganglion from the inferior cervical ganglion. The 1st white ramus however arises from the inferior cervical ganglion, while the grey ramus to the 1st thoracic nerve arises from the 1st thoracic ganglion.

rami communicantes which are present in connection with all the thoracic and the Ist, or sometimes the first two or even the first three, lumbar nerves. The importance of this white ramus communicans lies in the fact that in the operation of cervical ramisection it must not be divided, but is left in order to preserve especially the dilator fibres to the radial musculature of the iris.

(a) *The grey ramus communicans to the Ist thoracic nerve* (figs. 10, 12 and 13). Though generally single, this ramus is not infrequently double, the total thickness of the two being then about equal to that of the ramus when single. Even when single it often divides and joins the Ist thoracic nerve in two filaments.

It arises either from the inferior cervical ganglion or from the Ist thoracic ganglion if this is distinct from the inferior cervical ganglion.

In the majority of cases only one grey ramus is present, and takes the form of a short thick band arising from the posterior aspect of the lower half of the inferior cervical ganglion. It runs a course of only a few millimetres practically straight backwards (sometimes a little upwards) to join the anterior aspect of the Ist thoracic nerve where it lies in front of the neck of the first rib; it joins the nerve only a few millimetres lateral to its point of emergence from the intervertebral foramen. The ramus is completely covered anteriorly by the inferior cervical ganglion, which must be turned aside in order to expose it.

The ramus is almost always medial to the superior intercostal artery. Indeed, I regarded this as a constant relation until in one case I found it definitely superficial to the artery and joining the Ist thoracic nerve lateral to it.

This ramus, or the two branches representing it, seems to me to be most difficult of surgical approach. A consideration of the deep situation of the inferior cervical ganglion will serve to show the difficulty of reaching, identifying, and severing the ramus at operation.

(b) *The white ramus communicans to the Ist thoracic nerve* (figs. 10, 12 and 13). In every case which I have dissected the first white ramus communicans has been a well-defined and easily differentiated single nerve.

For convenience its course will be described from the inferior cervical ganglion to the Ist thoracic nerve, without regard to the direction of the impulses which it carries.

The white ramus communicans arises as a rule from the inferior cervical ganglion, sometimes from the Ist thoracic ganglion as will be discussed below. It may arise either from the upper or from the lower part of the inferior cervical ganglion, most often from the lateral aspect of the lower part, and always at some distance (1 to 5 mm.) below the origin of the grey rami communicantes to the cervical nerves. It courses almost directly outwards for about 1 cm., and joins the Ist thoracic nerve on its anterior aspect where the nerve is crossing anterior to the neck of the first rib; its direction, though principally outwards, is also slightly backwards, and, according as it arises

from the upper or from the lower part of the ganglion, respectively slightly downwards or slightly upwards. It joins the nerve at a point some distance lateral to the point of junction of the corresponding grey ramus. It is relatively longer than the grey ramus, and it lies anterior to the superior intercostal artery.

The chief points of distinction between the white and the grey rami are summarised in Table I.

Table I.

White Ramus	Grey Ramus
1. Paler in colour—almost white	1. Darker in colour—greyish
2. Leaves the ganglion from its lateral aspect and generally from its lower part	2. Leaves the ganglion from its posterior aspect and always from its lower part.
3. If the above distinction is not clear, the white ramus leaves the ganglion lateral to the grey ramus	3. If the above distinction is not clear, the grey ramus leaves the ganglion medial to the white ramus
4. Runs in a lateral direction	4. Runs in a posterior direction
5. Joins the 1st thoracic nerve lateral to the grey ramus	5. Joins the 1st thoracic nerve medial to the white ramus
6. Nearly always runs anterior to the superior intercostal artery, and joins the nerve lateral to the point where the artery crosses the nerve	6. Nearly always runs posterior or medial to the superior intercostal artery, and joins the nerve medial to the point where the artery crosses the nerve
7. Longer than the grey ramus	7. Shorter than the white ramus

I have noticed the following variations in the origin of the rami communicantes to the 1st thoracic nerve.

Frequently the inferior cervical ganglion is divided by a constriction into a larger upper and a smaller lower mass. In these cases it is usual for both the grey and the white rami communicantes to the 1st thoracic nerve to arise from the lower portion of the ganglion (fig. 12), which no doubt represents the 1st thoracic ganglion only partly incorporated in the inferior cervical ganglion. In two cases, however, in which this division of the inferior cervical ganglion existed, although the grey ramus to the 1st thoracic nerve arose from the lower part, the first white ramus arose unmistakably from the upper part of the ganglion (fig. 13).

Occasionally a completely separate 1st thoracic ganglion exists, connected with the inferior cervical ganglion by a thick trunk about 1 cm. in length. In such cases both the white and the grey rami communicantes to the 1st thoracic nerve arise from the 1st thoracic ganglion.

SUMMARY AND CONCLUSIONS

1. The observations contained in this paper are based upon nine complete dissections of the cervical sympathetic, as well as on the examination of parts of it in about a dozen other specimens.

2. The superior and inferior cervical ganglia are present in fairly constant positions in all cases, but great variability is found in the condition and position of the middle cervical ganglion.

3. As regards the middle cervical ganglion, the great majority of cases fall into two types, which are here termed the high and low types respectively. In the low type, which occurred more commonly, the ganglion lies in close association with the vertebral artery at the level of the VIIth cervical vertebra. In the high type, which occurred less commonly, the ganglion lies in close association with the inferior thyroid artery at the level of the VIth cervical vertebra.

4. In a few cases the middle cervical ganglion appeared at first sight to be absent, but in these cases a small thickening existed in the position occupied by a middle cervical ganglion of the low type. Reasons are given for regarding this thickening as representing the middle cervical ganglion.

5. Jonnesco has thrown doubt on the true ganglionic nature of some of the thickenings which macroscopically appear as ganglia on the cervical sympathetic. A number of such thickenings have been examined histologically, and nerve cells were found to be present in all cases.

6. The rami communicantes are described in detail, the description of the rami to any given nerve being based on all the specimens examined. Attention is drawn to certain grey rami communicantes which accompany the vertebral artery through the foramina in the cervical transverse processes, and which have not previously been stressed.

7. A number of points of distinction between the grey and white rami communicantes to the Ist thoracic nerve are indicated in Table I.

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